

KINETOCORE

Many synonyms: centromere, spot pt., kinosome and kinesome; primary constriction.

- Schneider Biol Bull 1936
1. If there is a well defined half spindle fiber it goes to a particular spot on the chromosome.
  2. At anaphase, this spot leads the chromosome poleward.
  3. By acentesis, the chromosomes cannot indefinitely persist mitotically. The loss of the chromosome need not occur immediately.

Not really

Most of our knowledge is recent. One "constrictor" is always associated with the fiber. These are by definition primary. Others, called secondary, may be associated with nucleoli. In some cases, the region is more chromatic.

see Chromosoma 1 (1939) Analysis rather complete. Chondroosomal techniques, with osmification, demonstrate the kinetochore; with finest differentiation a granule can be seen within. The kinetochore is different from the rest of the chromosome. Most easily demonstrated in arachnids, mammals.  
purple sphere (kinosome - Sharp, Hirschman).



constricted cap

at metaphase: (?)



Plant homologies obscure. In Tradescantia, and others, there is a projecting knob (sometimes double), which

Krapach & Chromosoma 1 '40. Feulgen positive

Private tap to Bot '40. On Bee there is a large kinetochore at each extremity, a clear knob. At anaphase, there is one knob (Darlington). Consider that many have no centriole.

Descriptl

The spindle spherule divides first.

Tage (see Day 2.2 eff 10/1930)

In living grasshopper, there is a gap at the point.  
In Decapods, there may be a centrole-like substance.

Hawkins Genetics 21

25 1940 basically lost.

Cytologically many organisms appear to have telomitic chromosomes. Ends of chromosomes are  
Hinton & Atwood 1940 peculiar Telomeres.

Haldane's Genetics 23 (1938) By X-ray, the kinetochore can be split, fractionally. The high frequency of such splits is disturbing.

Darlington J. Genet. 37 (1937) Misdivision of the centromere (Fritillaria spp., certain forms) leading to iso-chromosomes, branched chromosomes, etc. (The centromere may be pulled out.) Probably the essential part is fibrous, microfibrillating. Acc. Nebel: oriented micelles, permitted crystalline breaks.

Misdivision may be origin of attached X.

Concept of diffuse kinetochore

There is no experimental basis for a chromosome-test for terminal or centromeric kinetochore: centrole relation, but a good, general hypothesis. See below  $\rightarrow$  iso-chromosome temporarily. Pollister ....

Hughes-Schuldt & Rio JZ 1942 Localized & diffuse kinetochore. = localized kinetochore diffuse into its region.

12/4

## WHY DO CHROMOSOMES MOVE

(No consistent hypotheses)

Artifact

2 types:

1. Chromosomes pulled to pole by half-spindle fibers.
  - a. As chromosomes move the fibers do not thicken
  - b. When there is a large centrosome the chromosomes may be brought past the point of chromosome attachment.
  - c. Oriented intervals (should be in tension).
  - d. Establishment of metaphase: how?

[Watson proposes push: to equilibrium position: How? anaphase?]

See Rademaker, Bull Math Biophys '42

2. Diffusion currents [many botanists]

Schaefer Beitr Biol Pfl. 19 (1931) The apparatus is essential for demarcation of currents.

Honeycomb spindle: But fibers are attached to chromosomes, particularly kinetochores

Bilai notes: If cytoplasmic currents are stopped, the chromosomes continue to move.

Structure of plant chromosomes.

Is there then normally a spindle current???

V-shape in anaphase chromosomes.

Univalents X-chromosomes, move differently. If there are currents, should be no differential.

3. Tamm, Ljungh... Hydrostatic waves, microvibrations, induced by oscillation or pulsation of the centrole and possibly the kermone. A change of density of the chromosomes at metaphase must be presumed. The kermone must also vibrate if the forces are to be localized. Case of anastomosing spindles.

Propulsive centers are sum to move, but irregularly and slowly within the centrosome.

See Wassermann

29.

Waeemann

Hans d'Olde and d'Herscher. Movement is due to directed viscosity changes.  
Vol II  
Physically untenable.

Mary Bird Bull 1933 Scam

Zoophys 77 1937  
PNAS 21 1935

Theorell Diffusion potentials can arise by nonchemical situations; may modify kinetics of chemical reaction.

12/9/42.

Arch Entom 118: 446-456

Bélaï

1. Internal chromosome division is autonomous.
2. Spindle contains only continuous fibers.
3. Chromosomes are pushed into the equator by the growing out of fibers from both poles.
4. Kinetochore secretes some adhesive substance which attaches to spindle. When attached, the chromosomes are pushed to the equatorial plane.
5. The secretion moves up the continuous fibers toward the poles. This secretion is called the Zugfaser.
6. First split and movement autonomous.
7. The Zugfaser slides with the chromosomes.
8. 3 mechanisms for further movement.
  - a. Sliding along the Zugfaser.
  - b. contraction of Zugfaser
  - c. expansion of continuous fibers - Itens

In Arthropoda, there is no expansion of the Sternmäppen, or no distance between centrosomes.

Tagging of individuals, e.g. grasshoppers with large Sternmäppen.

Spindles are not all continuous fibers (kinetochore).

PS B121 (1936)

Fritsch

or paired:

Darlington: Electrostatic, after filling

1. Unsplit gamoattract; split cytoplasm. After splitting the nuclei; in meiosis chromosomes hold chromosomes together. At late metaphase prophase the chromosomes are already split, repelling other chromosomes. This accounts for the unusual diakinesis repulsions.

The centers go poleward, mutually repelling. Spindle is established through a redistribution of water. The chromosomes have kinetochores, but these do not split for a time. The first anaphase movement is the autonomous specific repulsion. The chromosomes reach the metaphase by centrole cytoplasm. Their charge now wanes, and the chromosomes go poleward.

Schraden

Y.L.

Does not take expansion of stem hairpin into account. Anisolebris; 1. Chromosomes attracted to centers of diakinesis; 2. When nuclear membrane breaks down, the chromosomes congress. The nuclear membrane must play some role. The metaphase is then set up quite orthodoxy. The ends of chromosomes must be rather peculiar for they are specifically attracted in the parthenote bagged. (This is true also for chromosomes with sub-terminal kinetochore.)

Methylytology 7 1936  
Scott J Morph 59 1936  
Korny Biol Bull 71:375 (1936)

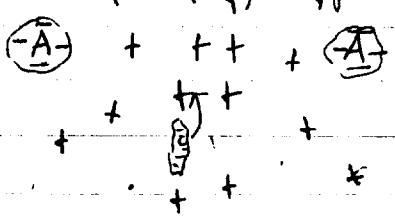
The cases of *Scaeva* and *Hecimethus* must be considered. Before division the chromosomes aggregate about the centrole. Then a monocentri mitosis; the V's are all pointed centrally; some chromosomes move away. Gamything, the spindle fiber impedes the movement. Autonomously chromosome movement proposed.

## FURTHER ON MITOTIC MECHANISM

The Electrostatic hypothesis proposed by R S Lillie

Lillie Am J Physiol 15:46-84 (1905) The first to emphasize (if hasty + erroneous) the colloid character of protoplasmic substrates. His work must be considered in the light of modern knowledge of double layer phenomena, and of diffusion potentials. The Donnan equilibrium expressions had not yet been formulated.

Chromatin, particularly chromosomes, are strongly electro-negative, or acid. The appearance of chromosomes in the ~~central~~ equatorial region is due to the extra's being also negative and the highest concentration distribution of mutually repelling  $\oplus$  charges, even if they arise from chromatin dissociation. In this event, consider reciprocal repulsion.



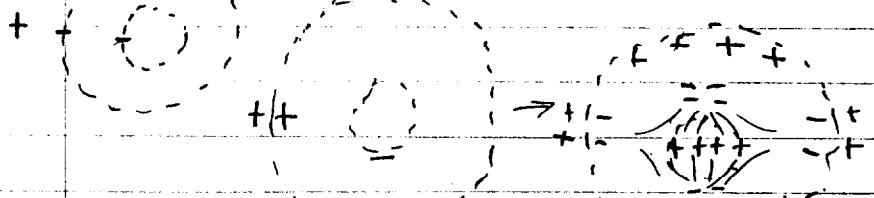
One cannot assume a concentrated + some charge. Must assume a uniform distribution of electropositivity at equator.

The basic assumptions, therefore, at metaphase are polar repellent and interstitial attractive field, with mutual chromosome repulsion. Models are reported of floating magnets, sperms, etc.

Lillie J Morph 22:615-720 (1911)

A more adequate theoretical basis is established

A breakdown in permeability equation



Then a charge in shape must be assumed.

Mitotic mechanism

What are the general conditions that must be satisfied by a theory of mitosis:

Diffuse kinetochore "can be regarded as a limiting case of multiple kinetochores.

1. Localized application of force to the kinetochore region.
2. Stable equilibrium, at metaphase
3. The existence of spindle fibers
4. A marked "sternining" in the intervals in some cases; its absence in others.
5. Anastral, acentric mitosis
6. Specificity of action: precocious or lagging X.
7. The anomalous cases of Saccula, Microcoleus and in micros
8. Body repulsion at distances
9. Synaptic attraction; saturation
10. In amoebae, the centrole-chromosome attractors
11. The division of the centromere.

ALSO

12. Autonomous split in c-mitosis, etc.
13. Pressure inhibition of chromosome movement
14. Anisotropy of the spindle
15. Concentration and congeession
16. Specificity of metaphase pattern, even in polyploid.
17. Bon rich cytoplasm. High Dilution Constant.
18. Existence and orientation of multipolar spindles, and the chromosome movements resulting.

12/11/42

NUCLEOLI

Plasmosomes and karyosomes.

↓ heteropycnosis of chromosome or part of it

Motter '99Gray

heavier than rest of nucleus. Generally visible in vivo. May be heterogeneous. Old rules of basophilia are inadequate, particularly in oogenesis.

The Feulgen-(Light Green) reaction is now employed. But almost certainly some Feulgen-negative components exist in the chromosomes. In most animals there is no plasmosome at anaphase; appearance is telophase. May sometimes be lost in the spindle, and drawn out considerably. But there is no direct continuity of the plasmosome from generation to generation.

In the lower vertebrate eggs, the plasmosome fragments into particles which may look like chromosomes, but are only lumpy threads than the latter. The plasmosomes here are Feulgen-negative.

Anaphinucleoli In *Cridus* (Hemiptera) the karyosome increases and accretes the plasmosome; the chromosomes (chromosomal X) breaking apart. Finally they leave the plasmosome for the spindle.

Agar QM 567 1923

In *Hausgelia*, a "mess-up" anaphinucleolus. Toward metaphase, the components segregate. Acc. to Agar, this is a fixation artifact, the fixation contracting the chromosome and forcing out a more liquid meshwork of the chromosome.

functions:

1. Paramecium — Too many cases of persistent nucleoli
2. Relation to chromosomes: In some animals the nucleolus is huge relative to the chromosomes which escape.

3. Secretion, yolk formation —

Schneider Archiv für Naturforsch. 89, 92 (1916) Myxine slime cell, very active in the young. (1 fish is an inevitable reader, after Mc Gregor). Development traced. Young cells show budding of nucleoli; squeeze through nuclear membrane.

Similar phenomena in trichopterous insect—Caddis Fly larva; detailed account in deuto- genesis, Seminal eggs —

After the ultimate gonium, no plasmosome. As egg grows, small irregular lumps in the cytoplasm; later, similar lumps in the nucleus; decrease proportionately to increase. Lumps fuse. Chondrosomes then appear in the cytoplasm. Simultaneously plasmosome has budded, extended in cytoplasm, chondrosome + body aggregate. Yolk spheres appear at the aggregates. Test for plasmosomes! During invasion, high P content as shown by (W.H. 1916) test.

Apparently not all plasmosomes are related specifically to chromosomes.

12/17/42

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Relations to chromosomes.

Zooplankton

Yokota, C. Bot Bay 86 (1928)

Plasmosome present at telophase; during prophase the plasmosome connects with a chromosome. The plasmosome decreases in size; His interpretation as filling the inside of a hollow tubular chromosome.  
(See Finsen). But the chromosome is not a hollow tube; the spindle is not continuous.

Mertens 2/AV 70:405 (1935)

Planta 12: (1931)  
Verbeek, J. Bot 80 (1934)

"Secondary constrictions" Appearance varies. Usually nothing more than a gap. Satellites (SAT). In some cases association with the plasmosomes. By early telophase, the nucleolar globule increases. In a few cases, the plasmosome is formed as a collar at the SAT.

Balbiani - Chironomus  
McLennan 2.2 off 21 (1934)

By X-Ray split of the organisms at (VI), a heteropycnotic region, the relationship between nucleolus, organizer and malpighi was established.  
[Geith opposed this interpretation].

Chromosome structure Gene string, with other stainable discontinuities on it (chromosomes)



There is more than one kind of plasmosome; do not generalize.

### THE GERM CELL

Darwin

Germules (submicroscopic, hypothetical units) at some time the germules are circulated and gather in particular, which accumulated themself.

Wernher

"Determinants" In differentiation, a germ cell is set aside, an undifferentiated cell.

Now recognized that all cells essentially have identical genotypes. Germ cells generally "immortal". Some somatic also (veg. propagation). Consider the parasitic role of the germ cell.

? point of optical differentiation of the germ in vertebrates  
Ceaseless, (futile) controversy!! Usually primordial germ cells have a large hypochromatic nucleus.

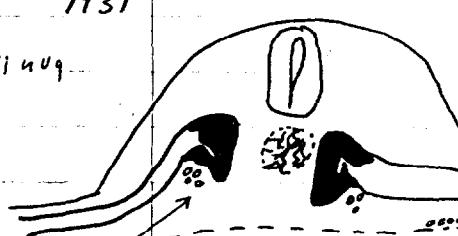
Waldeyer: - rather late differentiation, from epithelial cells.

Then idea of migration; now accepted

Allan, on Dodd's sporophils, truth

Heys Q R B 6 1931

most recent review now



In bull frog, the primary germ cells do not form the testes; the primordials disintegrate after starting

Saville KE 2 32 1921 to mature. Thus a new batch sets in.

Kingery Biol Bull 27 1914

by roclentrate any undifferentiated cell can give

Brown Festschr Hafner 1879 rise to the germ.

Haeftl Joseph 40 1925